PAPERNOISE

THE CONCERTODRONE

(circuit-bent Casio SK-1)

Build Documentation

v1.1 (10 June 2019)

www.papernoise.net

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Foreword

by Reed Gahazala

Hannes had done here exactly what I encourage in my book. That is, to look at my diagrams as starting points and then to expand the ideas of these basics in the ways circuit-bending so easily presents: switching becomes patch bays, pots are added to bends, new bends are sought and found. Hannes' expansions are well-documented and solidly realized. Good work.

Aknoledgements

Most bends in this project weren't discovered by me, but come from Reed Ghazala's great book *Circuit-Bending – Build your own Alien Instruments*. The present project would not have been possible without the inspiration and knowledge sharing by **Reed Ghazala,** so my biggest thanks go to him for his amazing pioneering work!

Also a big inspiration: **Nicolas Collins**, who's book *Handmade Electronic Music* I also highly recommend!.

Ghazala's book is currently out of print, but should be available here: www.anti-theory.com/book/, if it gets reprinted.

On this page you can also find the original diagram (scroll down, it's the first item in the "Downloads" chapter): wiley.com/WileyCDA/WileyTitle/productCd-0764588877.html

Make sure you check that as well, since it will make some things in this project easier to understand.

Many solutions have been, in some way or the other, suggested or facilitated by the wonderful global circuit bending community. To be more specific, I'd like to thank:

- **Shane Williams** (for providing the great-sounding Synthacon-style VCF for this project), plus a lot of help and advice!
- **akirasrebirth**, because without his help I would not have been able to complete the last steps and finally finish this project
- **Elizabeth Busani** for making the wonderful photos of the Concertodrone that can be seen in this PDF document.
- the **Secret Media Lab** collective for playing a big role in my getting into circuit bending in the first place
- **Circuit Ben**, **circuitbenders.co.uk** and everybody in the "**circuit benders are not crazy we are artistic**" group
- **Casper Electronics**, their website is full of useful hints on the SK-1

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The Photos in this document are © of Elizabeth Busani

Build documentation

Intro

Before you even think about building something like this, you should know a couple of things. It took me about 3 years and a lot of wasted money to complete this project. I have built and dismantled the thing a dozen times and went through 4 iterations for the front panel.

Despite this, there's still things that are not working properly, the audio output is rather noisy and there's a bunch of missing features which I wasn't able to implement. You need to be a good craftsman, know about electronics and have some previous experience with bending and DIY to be able to even attempt this. You might be more talented than I am, and maybe it will be a piece of cake for you, but just in case, accept this friendly warning and don't take things to easily, because it's a bumpy road and it's definitely not a beginner-friendly project. This notwithstanding, once you have it all working, it's incredibly rewarding! There's nothing like building your own instrument and the SK-1 is probably one of the greatest keyboards to bend!

The bottom line is: if you don't have a lot of experience with circuit bending, complete some easier projects first, practice soldering, get some DIY kits to level up your skills, then come back to this. If you're confident in your skills, have a go at it and have fun!

Disclaimer

By following the instructions in this document you agree that if – in the attempt of executing this project, or a part of it – you hurt yourself, other people or animals, burn your house, destroy your equipment, waste the little money you had, fall into depression, hate the world or decide to quit making music, you will not blame it on me, neither legally nor by calling me out on the internets.

You acknowledge that you will perform any of the herein illustrated modifications/augmentations completely at your own risk.

I did warn you, don't say I didn't when you screw up, ok?

Safety Precautions

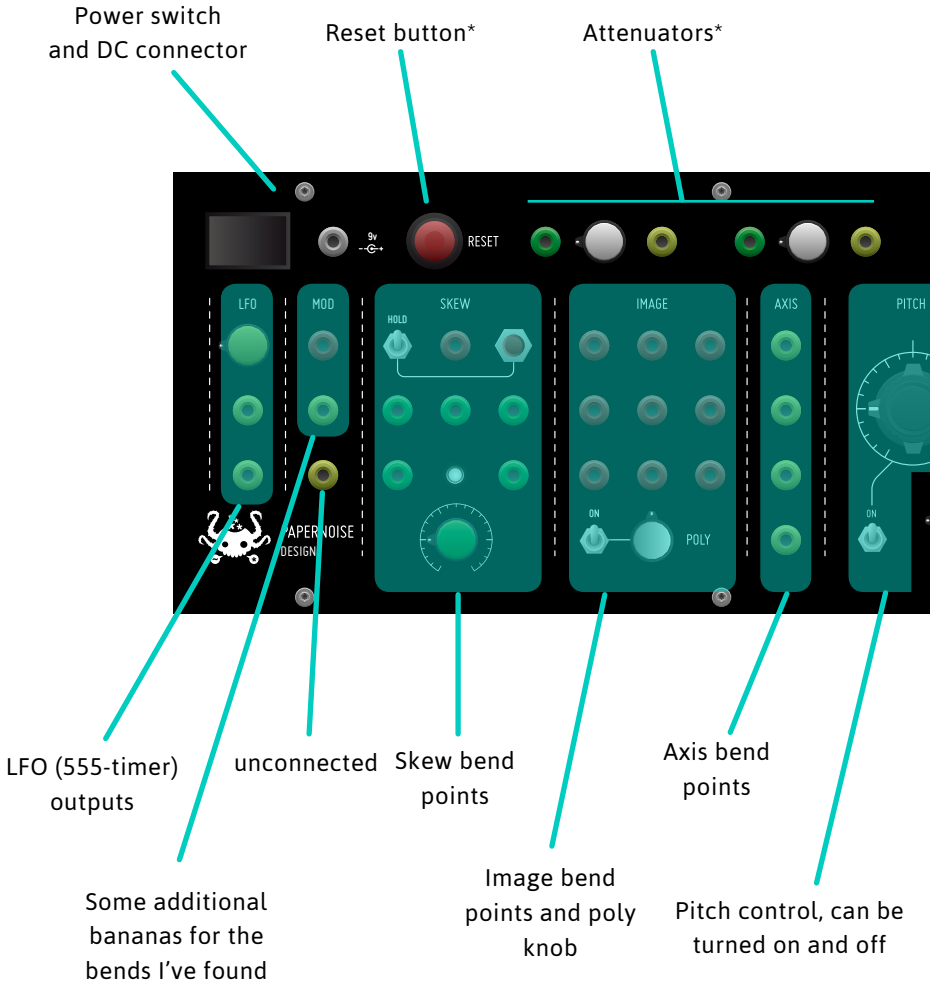
Even if this is not a beginner's project (so if you attempt this, you should know these things already) let me remind you of a couple of safety precautions:

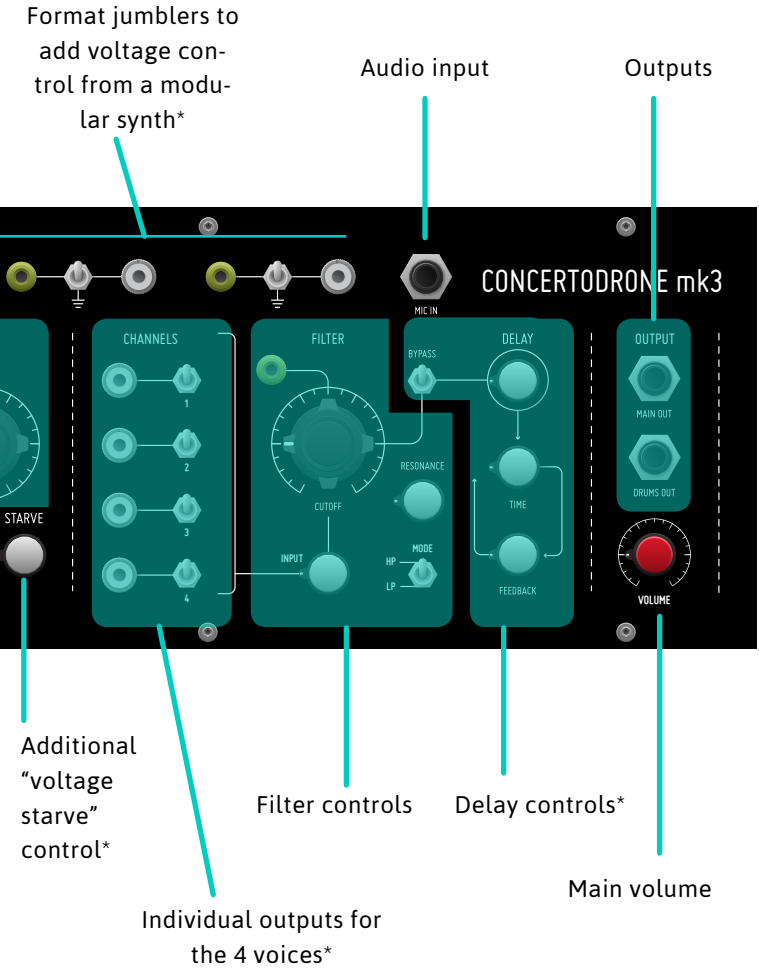
- **Never mess with a circuit that is plugged into the mains voltage** (i.e. plugged into a wall outlet). Only work on battery-operated devices. Fortunately the SK-1 will happily run off a bunch of AA batteries.
- I'm legally bound to remind you that the soldering iron can become really hot. Like in burning-your-eyes-out hot.

This said … let's dive into it!!!

The Front Panel, Overview

This front panel has many issues, which I'll get into soon. The main purpose of showing it here (and providing the CAD files), is just to be of inspiration, and maybe to serve as a starting point for your own creation.





(*) caveats apply! Read more about it on the next pages...

General Explanation and Notes

Reset Button: I was never really able to make this work, so I can't help you here. Sorry.

Attenuators: The signal is passed through a 10K potentiometer. The idea was to have something to get finer control over the connections between bend points. Unfortunately it turned out to be a bit useless. I wouldn't add these if I were to go back.

Format jumblers: I added these to make it easier to use voltage-control signals from a modular synth. In the end the only thing that I can CV-control is the filter, so these aren't very useful either. It would be best to try out these things on a breadboard before adding them to the panel/instrument.

Input: You can connect this jack directly to the points on the circuit where the line or mic jack is soldered on the PCB. You can of course also add two jacks to have both mic and line inputs. Depends a bit on what you want to do with it.

Main outputs, individual outputs for the 4 voices: The SK-1 will let you "tap" the 4 voices and the drums as independent outputs. In the end though, the 4 independent outputs weren't as useful as I thought, especially since the point where I "extracted" the signal was before the envelope/VCA. My idea at the beginning was to take the 4 voices, mix them via a passive summer circuit and then take them to the output jack, so I could remove them from the main output using the switches. Unfortunately this sounded kind of bad. The volume was way too low and since the signal was not getting processed by the envelopes it was also lacking the dynamics. Once again, I realize in retrospect that I should have tested this better while planning the whole thing.

In the final version the main output is just he mixed signal, taken from the headphone output. I also added a separate output for just the drums. Unfortunately I can't remem-

ber where it's wired to and to check that, I'd have to disassemble the whole thing again. But it's an information that can be easily found on the web.

LFO: This is a simple 555-timer-based circuit that outputs both a square wave and a ramp. More about it in the following pages

Bend points, Mod, Skew, Image, Axis: These I'll explain in more detail in the next pages.

Pitch control: This lets you change the base pitch of the circuit, more about it later.

Additional "voltage starve" control: This pot is positioned as a variable resistor between the PSU and the main circuit, it did add some nice grit to the audio at the beginning, but for some reason, it's not working anymore. In general, I'd say, this is not worth bothering with, but you're free to try. If I'm not wrong I used a very low resistance (I think 20 Ω) for this one, since anything above it would just silence the output.

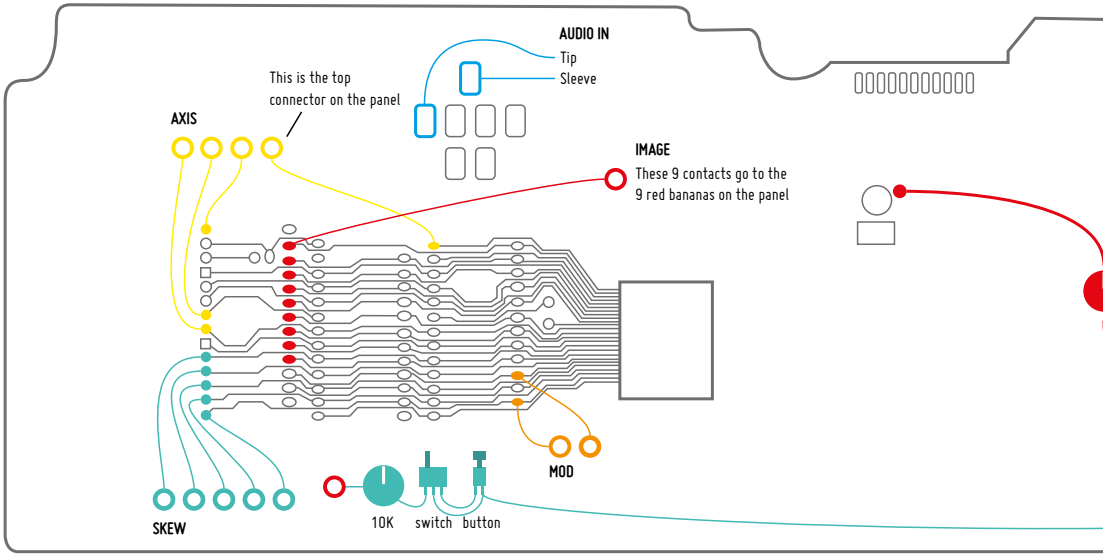
Filter&Delay: two additional circuits I have added in the signal path.

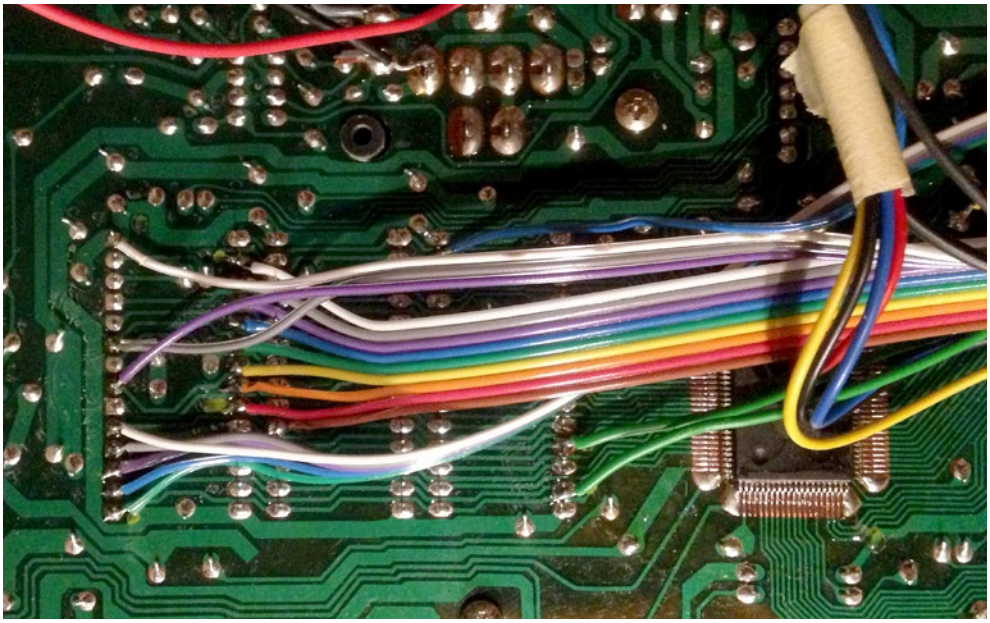
Main Volume: Another thing that turned out to be less useful than initially thought. Since I reverted back to taking the SK-1's mixed output. I already have a slider to control the volume on the instrument, which makes this a bit redundant.

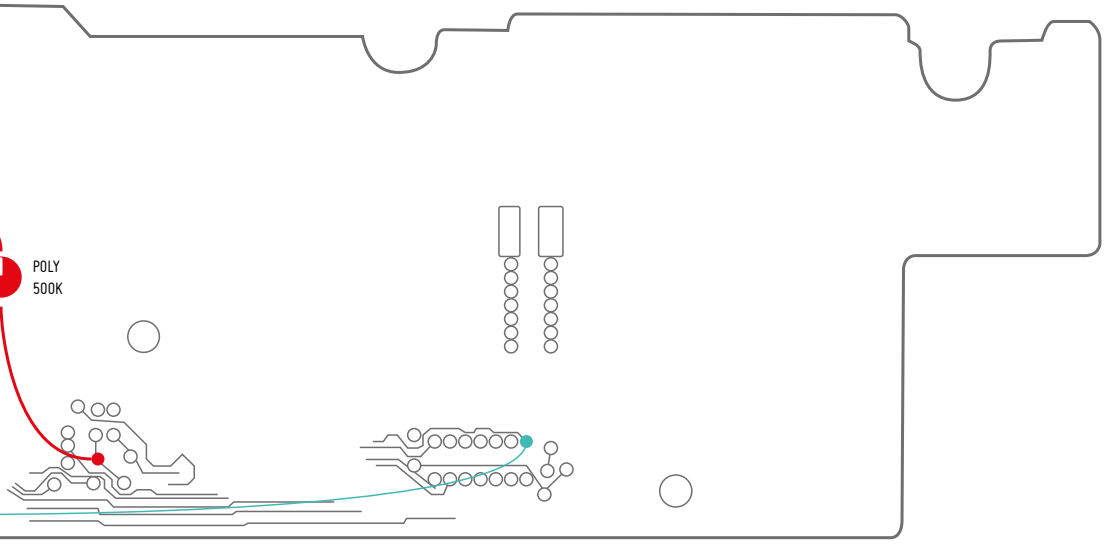
Bend Points

As previously mentioned, many of these bend points are well documented in Reed Ghazalas book, which is where I got them from. While Ghazala suggests to use switches to make the connection between points, I opted for banana connectors and patch cables. This has the advantage of letting you experiment with the circuit even after you have "wrapped the whole thing up" since all points on the circuit will be exposed to the front panel. The disadvantage is that some connections might freeze the SK-1. If you do it like I did, you'll need to learn which ones are the good ones. Ghazala grouped the bend points in 3 groups: **Skew**, **Image** and **Axis**, I kept this naming as a reference and a tribute to his work. The jacks named "Mod" are my own additions. Don't do anything new by themselves (btw. one them is already present in the "Skew" section), but I found that they would make interesting glitches when connected to the LFO output.

Some bends have a "main" connector, like the red one for the Skew mods, or the top connector in the Axis section. You can experiment with other connection schemes though. The graphic below shows the wiring under the hood, I've kept the colours close to the ones used on the front panel to make it easier to understand. I suggest to use "rainbow-coloured" ribbon cables to make the connections, since these will make it easier to keep things organized.



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500K

The Pitch Bend Mod

One of the cool things you can do to the SK-1 is to add a potentiometer that will let you set the base pitch higher or lower (the low settings are the best!).

There's several ways to pitch-bend the SK-1, some are easier and just involve adding a potentiometer to the right spot, others – like the solution I'm about to propose here – requires an extra circuit to be added.

To perform this pitch-bend Mod you will need an **LTC1799** IC. Unfortunately this IC only comes as an SMD (those really tiny ones) component and will need a certain circuit to run properly. Fortunately there's a couple of online resources that will sell you pre-made LTC1799 modules. I got mine from here:

www.circuitbenders.co.uk/forsale/LTC/LTC.html

Getlofi.com also sells a similar circuit here: getlofi.com/shop/ltc1799-precision-oscillator-for-pitch-control/ but the wiring might be a little bit different.

This module will work as a frequency-controllable oscillator and – if added properly to the circuit – will replace the internal clock so you can tweak how fast the circuit will work (and hence determine its pitch). When the mod is bypassed (that's what the switch is there for), you can still use the trimmer on the bottom of the SK-1 to tune the keyboard. I suggest that you keep that somehow accessible (I've made a hole on the bottom plate of mine so I can reach it with a screwdriver. The advantage is that you can use the trimmer to set the "normal" pitch that the SK-1 plays in when the mod is not engaged, which can be useful.

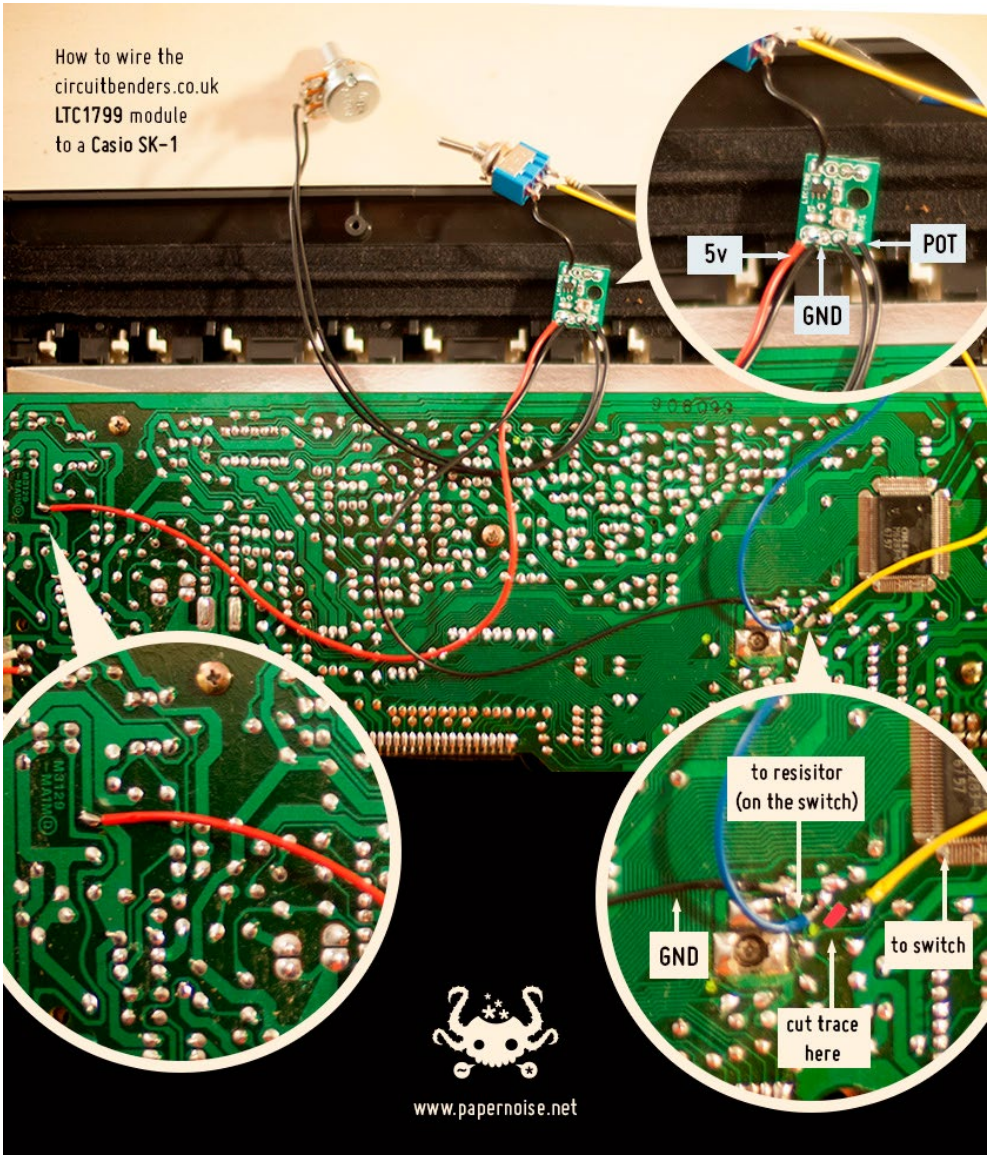
The image on the right illustrates how this module is to be added to the SK-1 circuit. make sure you also read the infos in the circuibenders.co.uk link above.

Note that you need to cut one trace on the SK-1's PCB, you can do that easily with a sharp pointy knife. I have used a **linear 100K** pot to control the LTC module, but of course you can experiment with other values as well. The resistor attached to the switch is a **500Ω** one and should give you a A=440 tuning (I've taken this from the instructions for the old Get Lo-Fi LTC1799 module).

Further Ideas:

If I were to go back I'd add two potentiometers and a DPDT switch to commute between the two. So you can set a pitch on one, then move to the other one, mess with it as you like and always go back to that pre-set pitch on the other potentiometer.

You could also put the two pots in series, so one would be used to set the base pitch and the other one as a kind of pitch-bend control. As an alternative to the potentiometer, a light-dependant resistor (LDR) could be used to enable some gestural control.

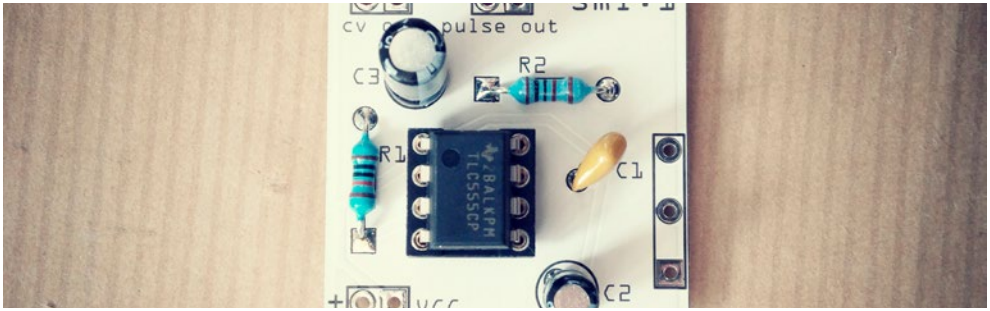


The LFO

Several years ago, together with fellow DIY enthusiast and bandmate Michele Cagol, we created a small 555-timer-based circuit loosely inspired by Forrest Mims' Stepped Tone Generator, and by some simple 555-based circuits developed by Getlofi.com and Synthrotek (among others). We called it the **sml.1** and used it in a bunch of DIY projects. More info about it can be found here: www.kvsu.net/projects/sml-1-555-oscillator/

I used one of these oscillators in the SK-1, though it's usefulness has proven to be a bit limited. You can use it to control the filter (if you have a voltage controllable one) and you can use it to produce some chaotic results when patched into some of the bend points, but I also found that it tends to bleed a bit into the audio signal so I'm not sure if I would recommend it.

If you want to try it, we should probably have some kits left, or you can get one from getlofi.com: getlofi.com/shop/555-timer-module/



Filter and FX

As previously mentioned I used a Synthacon-style voltage-controllable filter circuit developed by one of Britain's most talented circuit benders: **Share Williams**.

It's a relatively simple, nicely overdriven VCF with cutoff, resonance and drive controls. There's also a CV input to control the cutoff frequency. The circuit can run in lowpass, highpass and bandpass mode, though I only added control for the first two. In hindsight, bandpass might have been more interesting than highpass.

I also added a cheap delay right after the filter. This is another choice I regret. The sound of the delay is kind of awful, so I always keep it bypassed anyway.

Other Filters

There are of course many other options when it comes to filters!

A popular mod for the SK-1 is the so called **Phat Philer Bank** mod, more info can be found here: electro-music.com/forum/phpbb-files/phat_philter_bank_mod_175.pdf. The Sk-1 does have some internal CVs which can be used to drive a filter's aperture, though I was never able to make that to work for me, plus the type of sounds I like to make with this instruments don't really need a key-triggered envelope anyway.

Power Supply

The SK-1 can run either from a bunch of AA batteries or from an external power brick, which needs to deliver a tension of 7.5V. I first made a little PSU module to regulate 9V down to 7.5V. Unfortunately I can't remember the specifics of this PSU module, and removing it from the circuit to check the components would be a major hassle.

Williams' filter also came with a small PSU module, intended to smooth out the current and prevent noise from getting into the VCF's output. Interestingly the output of that module was also 7.5V, so I ended up powering everything from there.

Later I found that the 555-timer LFO would bleed into the audio signal, so I tried to run that from the previous PSU module I had built, but it didn't seem to make much of a difference. The problem is still unresolved until now.

Of course you might not need the additional PSU circuit at all. I initially added it because I wanted to run everything from a 9V power brick (since I have lots of them around) and the filter needed its own PSU module anyway, but you could also just use a 7.5V brick and skip all the additional circuitry.

More Ideas to Explore

Here's some more ideas that you might want to consider. I haven't tried any of these, so I don't know how complex they are, nor if they even work at all.

It is possible to add **MIDI control** to the SK-1 using this mod here:
www.youtube.com/watch?v=GQcJBLLhkMo

You can change the **behaviour of the built-in envelopes** with the so called "slo-AD" mod:
www.warningwillrobinson.com.au/index_files/SloAD.htm

It's been often pointed out that you could add **trigger-based control** to the built-in step sequencer by using a switch IC like the 4066 or 4016. A basic tutorial on adding that to a bent toy can be found here:
little-scale.blogspot.it/2013/05/circuit-bending-basics-3-emulating.html
In theory the switch IC could also be driven by 5V trigger pulses coming from a modular synth, or a keyboard with an analogue gate output, as long as it does not exceed 5V.

Useful Links and Further Reading

Reed Ghazala's website: www.anti-theory.com

Gazala's **original diagrams:**
wiley.com/WileyCDA/WileyTitle/productCd-0764588877.html

Nicolas Collins' website: www.nicolascollins.com

and his free **hacking manual**: www.nicolascollins.com/texts/originalhackingmanual.pdf

The official Casio SK-1 **user manual**:
http://electro-music.com/forum/phpbb-files/sk1owners_661.pdf

Casper's SK-1 pages: casperelectronics.com/finished-pieces/casper-sk-1

A useful tutorial on how to bend the SK-1: www.intelligentmachinery.net/?page_id=390

How to solder bend points to an SK-1:
www.instructables.com/id/Tutorial-on-how-to-solder-bend-points-to-a-SK-1

Little Scale's blog, full of great stuff on circuit bending
https://little-scale.blogspot.it/search/label/circuit%20bending

circuitbenders.co.uk, getlofi.com

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Did you find this useful and interesting? Do you want to support my work in some way?

If this is the case, here's something you can do:

Check out my music

First of you can lsiten to **kvsu's album *The Malosco Sessions***. Since you're into circuit bending, you might be into our type of sound (which makes large use of circuit-bent and DIY gear). More info on the album and audio streaming here: kvsu.bandcamp.com/. Also, It's a free download (it's name your price, so just enter zero to get it for free).

The album can also be ordered in **vinyl** format from bandcamp.

You can also check out one of my older projects, a soundtrack for a super8 sci-fi short film called *Killer Aloe*: resofame.bandcamp.com/album/killer-aloe-from-outer-space-original-motion-picture-soundtrack-rsfm-0003

Last but not least, here's my youtube page:
www.youtube.com/channel/UCckyExODW5XmmGJKnLeBolw

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